

James Webb Space Telescope

Mirror Manufacturing
Status

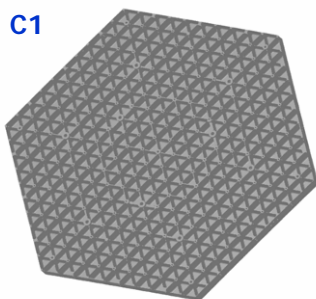
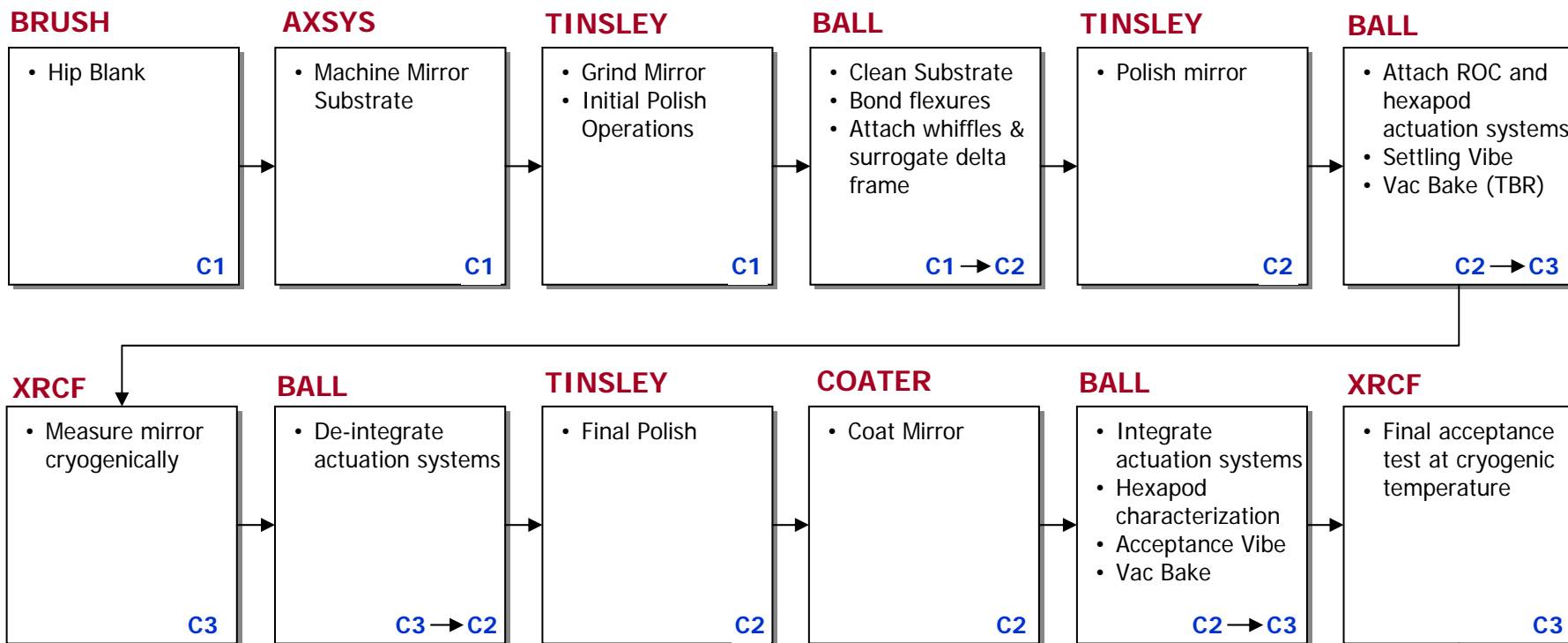
Ben Gallagher

Technology Days in the
Government 2006
September 18, 2006

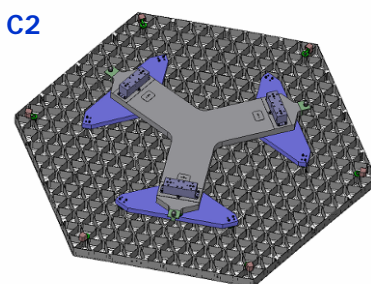




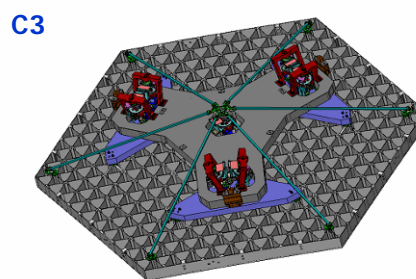
JWST Mirror Processing Flow



Mirror Substrate Only

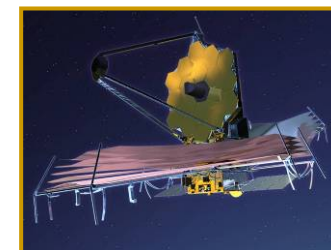


Bonded Flexures and Whiffles
Surrogate Delta Frame



Fully Assembled PMSA

Deliver
to
NGST

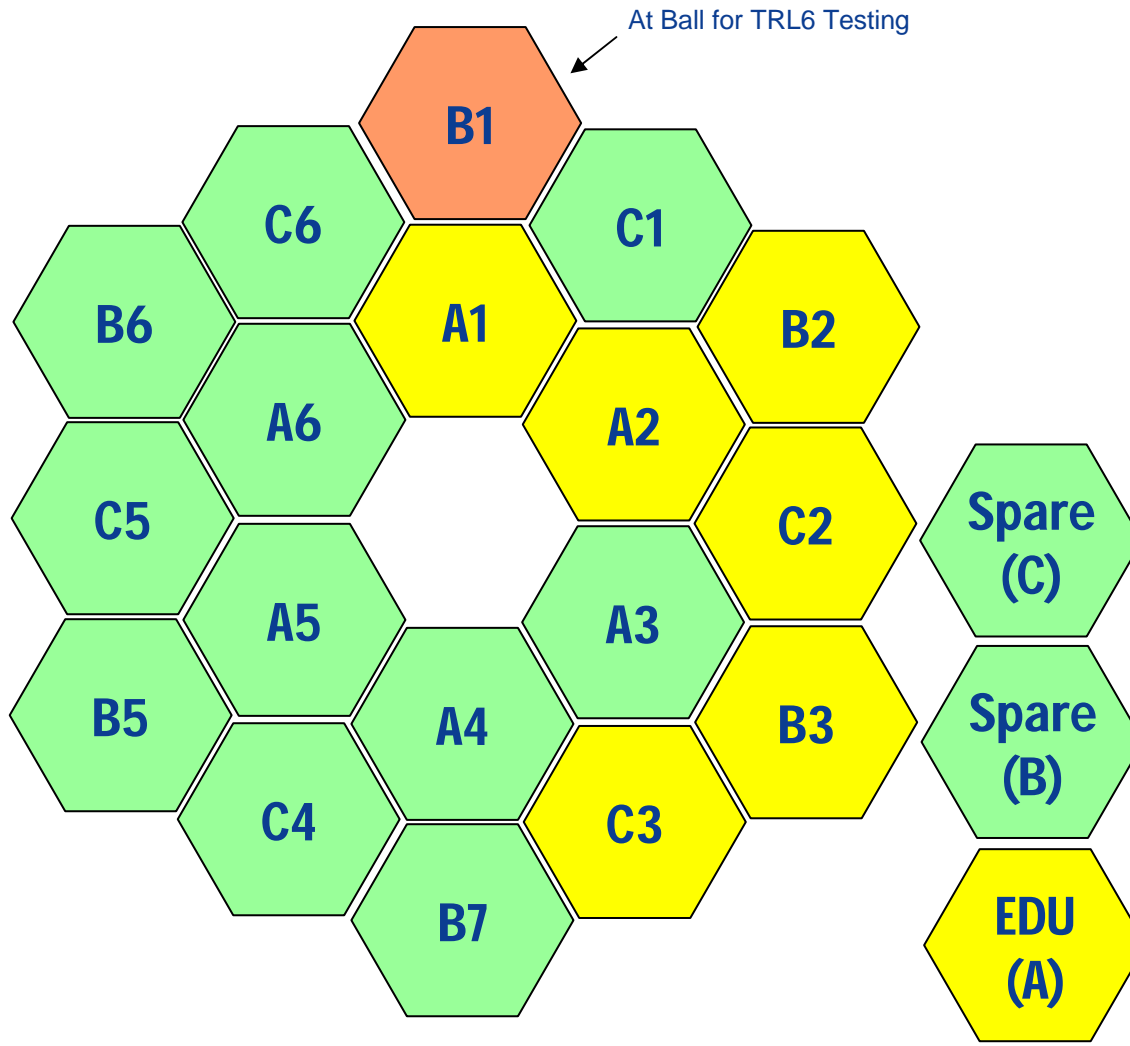




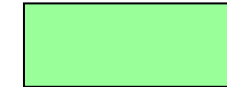
JWST Mirror Status – As of 8/4/2006



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BRUSHWELLMAN
ENGINEERED MATERIALS



AXSYS
TECHNOLOGIES



tinsley



Ball Aerospace
50 Years



Brush Wellman Status – All Blanks Finished!



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All PM Blanks shipped to
Axsys for Machining

TM Blanks
shipped for
Machining



SM Blanks
shipped for
Machining

Brush currently working on PSAS components
(i.e. Delta Frames, Struts, Whiffles)



Axsys Technologies - Status



- Facility, fully ramped up and in full production
 - 8 CNC Milling Machines
 - 2 Coordinate Measuring Machines
 - Heat Treat Chamber
 - Acid Etching Station
 - Inspection and Mirror Prep Areas
- Status as of 8/4/2006
 - Primary Mirror Segments
 - 8 Segments complete, 13 segments in work
 - Secondary Mirror
 - First SM Blank in work, 19 of 50 operations complete
 - Second SM Blank received at Ball and waiting to be shipped to Axsys at the completion of SM1
 - Tertiary Mirror
 - Blanks received from Brush Wellman
 - TM Process Review Complete
 - TM Mirror Processing has begun



Axsys has begun shipping mirrors!



PMSA EDU (EDU-B, A0) PM Segment



PMSA EDU as machined during packing operations and then shipped from Axsys



Beryllium Subcontract Accomplishments Last Month – Axsys Technologies



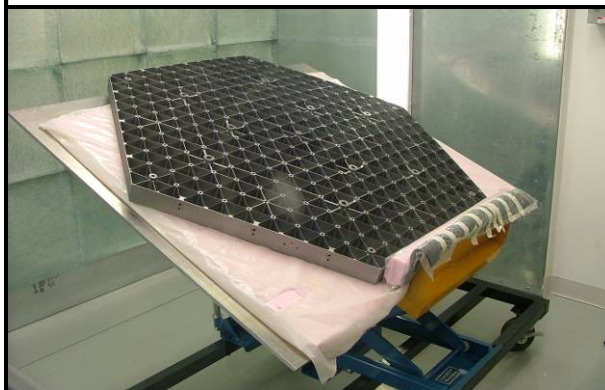
Batch #1 (Pathfinder) PM Segments

SN A1 Complete



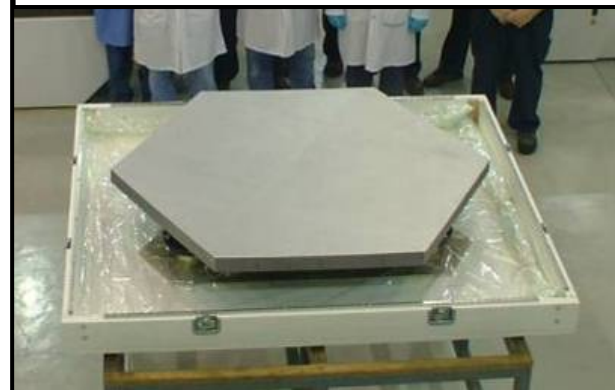
PMSA #1 (EDU-A / A1)

SN B2 Complete



PMSA #2 (6 / B2)

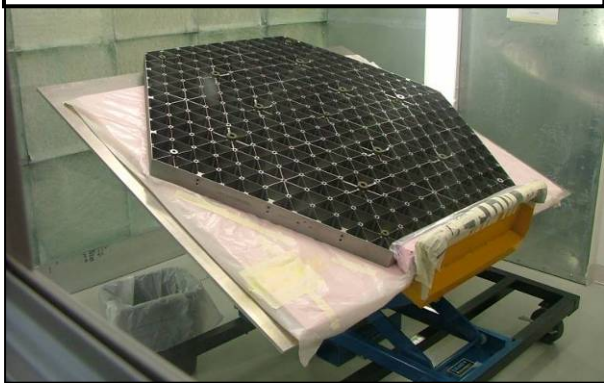
SN C2 Complete



PMSA #3 (7 / C2)

Batch #2 PM Segments

SN A2 Complete



PMSA #4 (5 / A2)

SN B3 Complete



PMSA #5 (11 / B3)

SN C3 Complete



PMSA #6 (12 / C3)



Beryllium Subcontract Accomplishments Last Month – Axsys Technologies



Batch #3 PM Segments



PMSA #7 (13 / A4)



PMSA #8 (17 / B5)



PMSA #9 (4 / C1)

Batch #4 PM Segments



PMSA #10 (16 / A5)



PMSA #11 (20 / B6)



PMSA #12 (15 / C4)



Beryllium Subcontract Accomplishments Last Month – Axsys Technologies



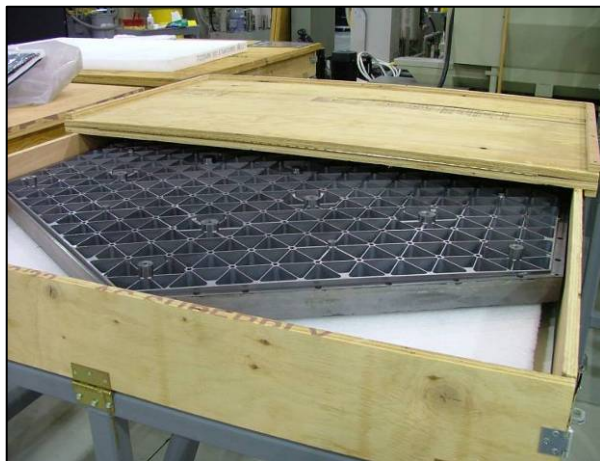
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Batch #5 PM Segments



PMSA #13 (8 / A3)



PMSA #14 (22 / B7)

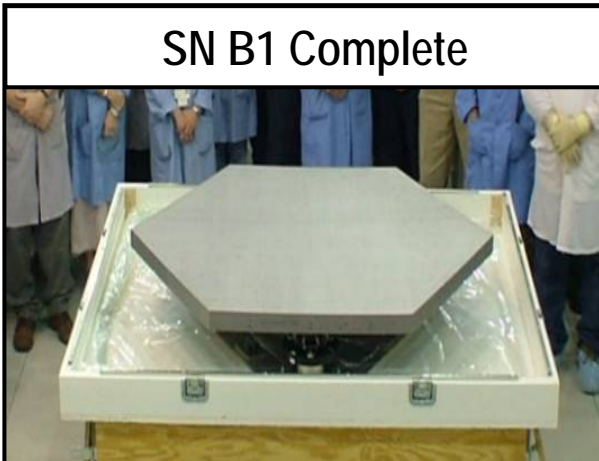


PMSA #15 (18 / C5)

Batch #6 PM Segments



PMSA #16 (19 / A6)



PMSA #17 (3 / B1) (TRL6 PMSA)



PMSA #18 (21 / C6)



Beryllium Subcontract Accomplishments Last Month – Axsys Technologies



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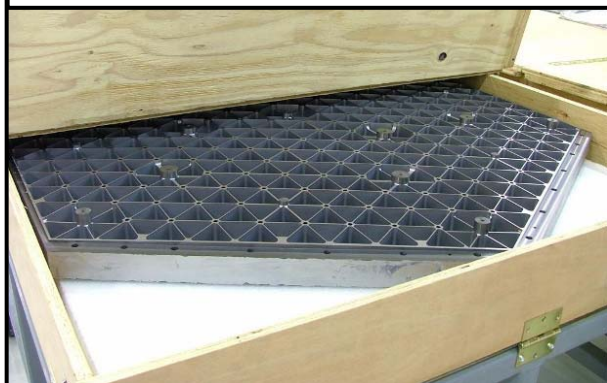


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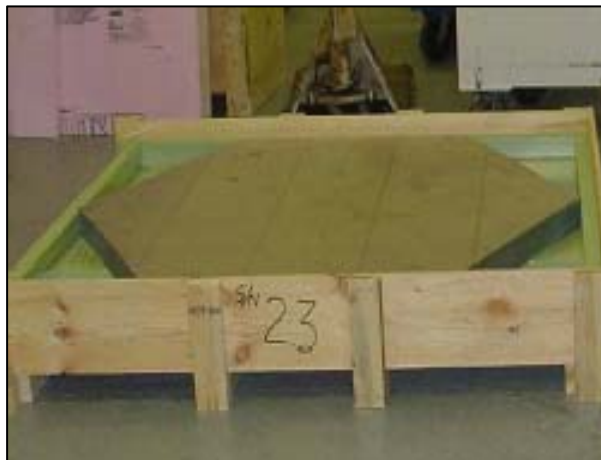


Batch #7 PM Segments (A, B, C Spares)

SN EDU Complete



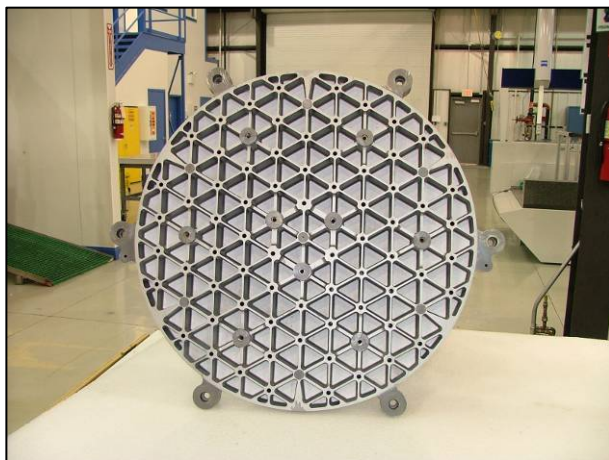
PMSA EDU (EDU-B / EDU)



PMSA #19 (23 / B8)



PMSA #20 (24 / C7)



SM Flight 1 (SM1)

*Second SM Blank received at
Ball and waiting to be shipped
to Axsys at the completion of
SM1*

SM Flight 2 (SM2)



Tertiary Mirror (TM1)



L3 Tinsley Major Accomplishments



- Manufacturing Process & Metrology Equipment Development is Nearing Completion
- The Starting of CCOS operations on EDU
 - Initial Thermal cycling and figure grinding operations complete
- The Receipt of 6 Flight Primary Mirror Segments
 - 3 Pathfinder Segments have been entered into Tinsley's manufacturing flow
 - Additional mirrors being stored for future processing
- L-3 Tinsley received AS9100 certification and QA flight readiness / ISO activities have been completed in support of flight processing



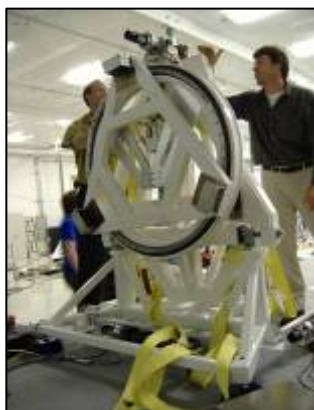
Manufacturing Process & Metrology Equipment Development is Nearing Completion



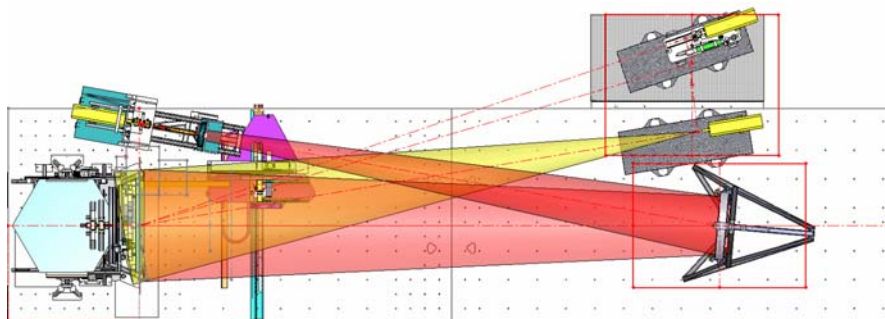
IR Scanning Shack-Hartmann
Wavefront Sensor (2x)
2 in integration and test



Computer-controlled Optical Surfacing Machines
(8X) 2 qualified, 1 test bed, 5 in integration and test



Visible Interferometric
Test Station (2x)
2 in integration



CMM Profilometer (2x)
1 qualified, 1 waiting integration



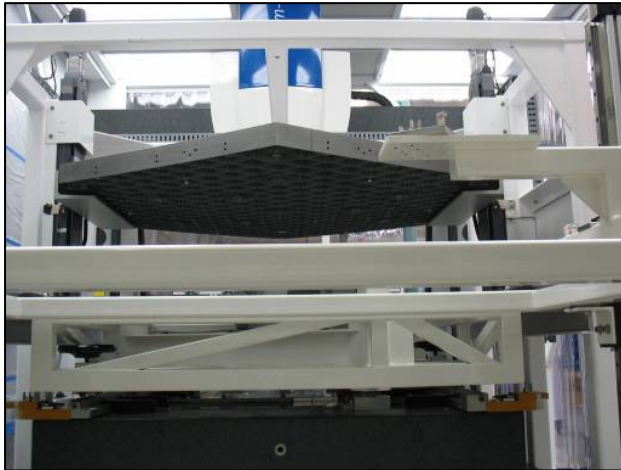
Thermal Processing (2x)
1 qualified, 1 in integration



Beryllium Subcontract Accomplishments Last Month – L-3 Tinsley



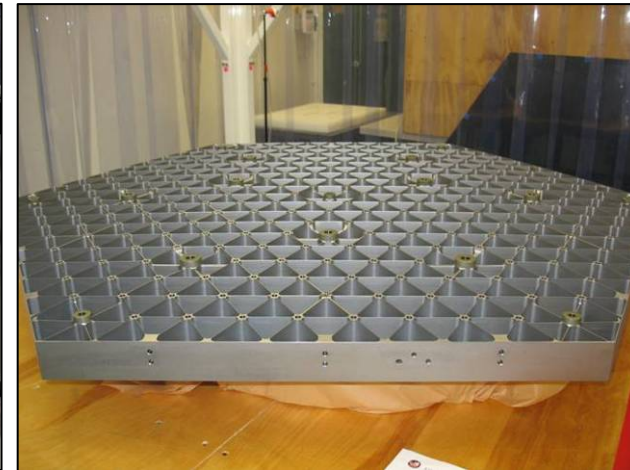
Batch #1 (Pathfinder) PM Segments



PMSA #1 (EDU-A / A1 / A1)



PMSA #2 (6 / B2 / B2)

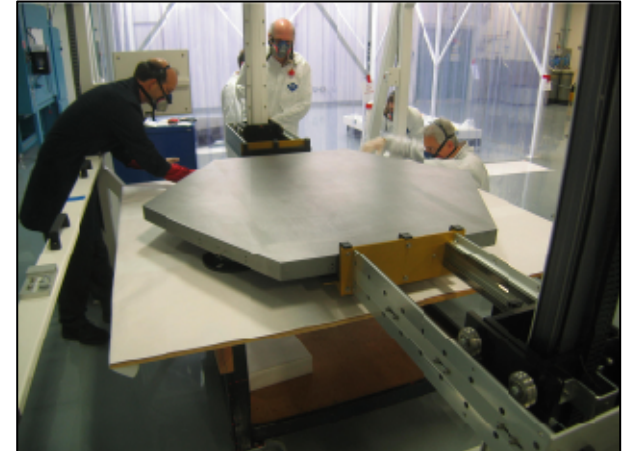
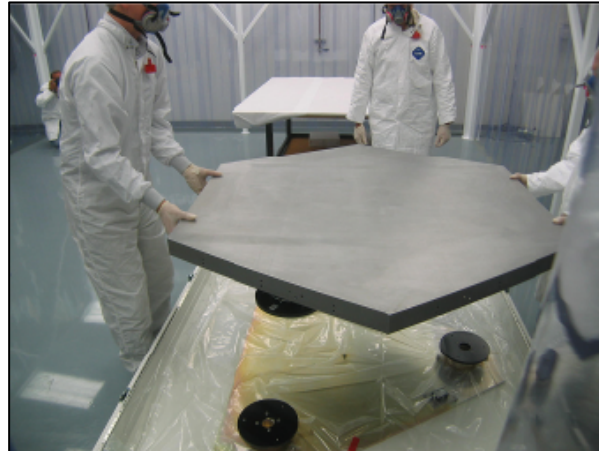


PMSA #3 (7 / C2 / C2)

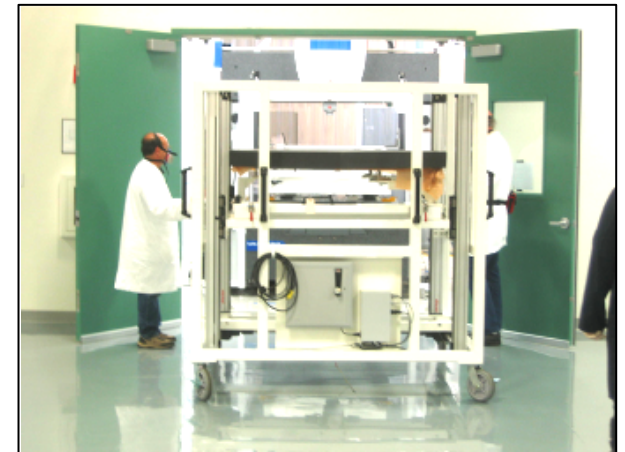
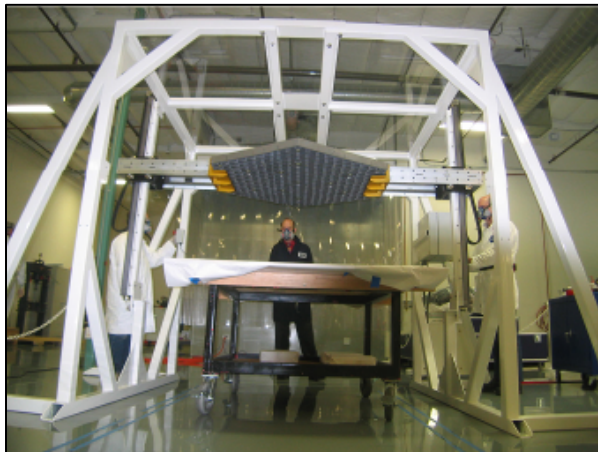
- 6 Flight Segments in addition to the EDU have been received at Tinsley
- As of 8/4/2006
 - Batch #1 (Pathfinder) segments are in various phases of incoming metrology and stabilization processes
 - CCOS Grinding operations on segment A1 started in August
 - Batch #2 segments are going through incoming inspection

EDU Processing at Tinsley (1 of 3)

- EDU has been pathfinder of Tinsley process in preparation of processing flight Segments

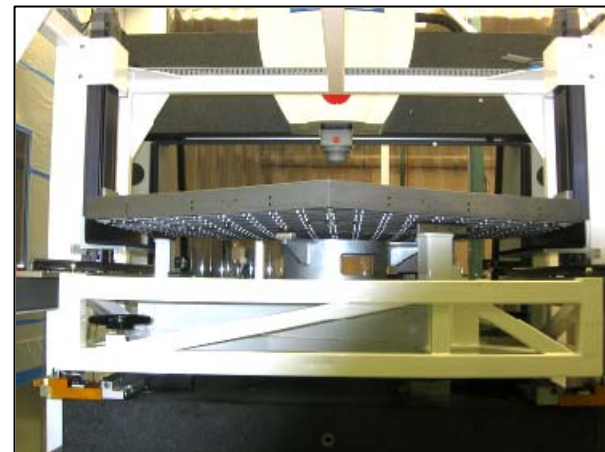


PMSA EDU unfastened from shipping container base, manually transported from shipping container to handling cart



PMSA EDU elevated from handling cart, transferred to transport cart and aligned for docking to CMM

EDU Processing at Tinsley (2 of 3)



Transport cart docking with CMM and PMSA EDU installed onto CMM fixturing for measurement operations



PMSA EDU removed from CMM, transported and prepared for cryo thermal cycling and installed into cryo thermal chamber



EDU Processing at Tinsley (3 of 3)



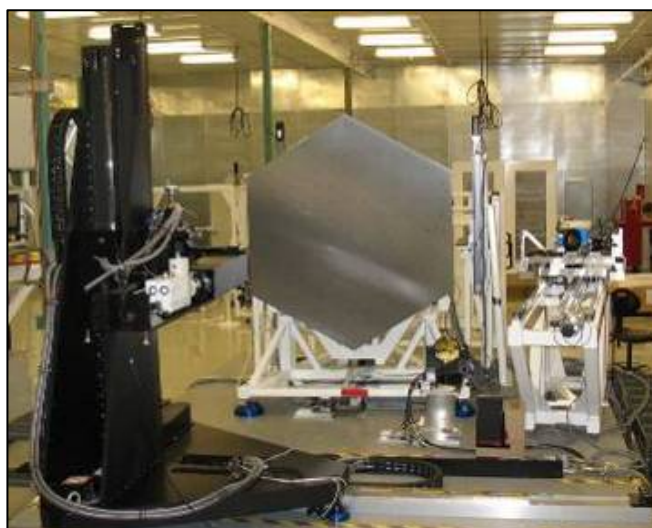
PMSA EDU on CCOS Machine



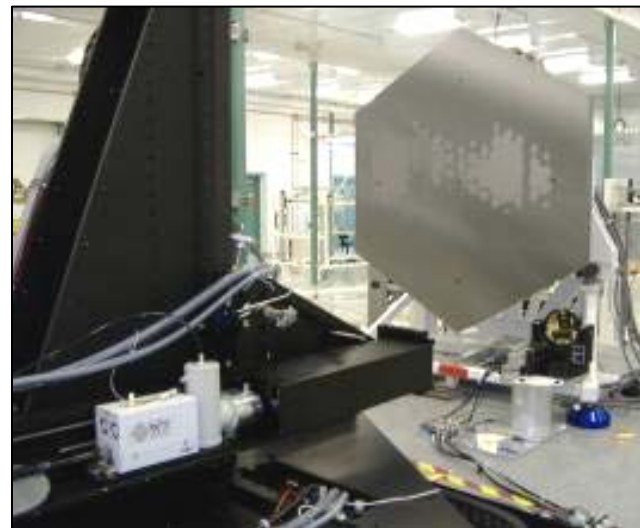
PMSA EDU being cleaned after CCOS Grinding Run



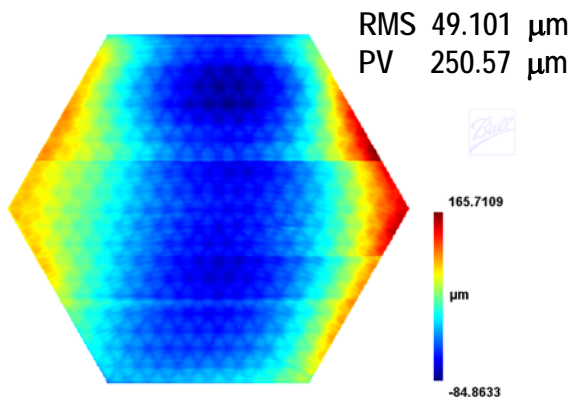
Primary Segment Mount in Use



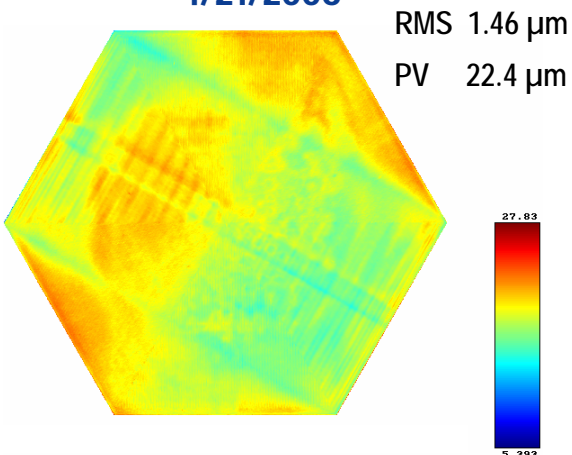
PMSA EDU being measured with Scanning Shack Hartman Sensor



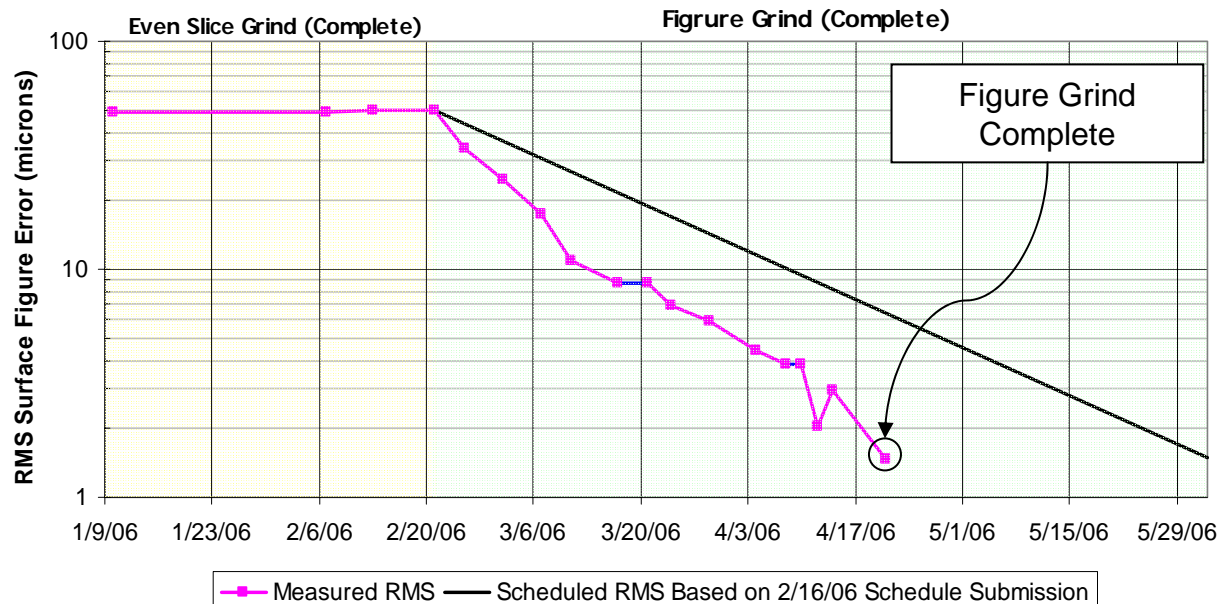
PRE CCOS PROCESSING FIGURE 1/10/2006



POST FIGURE Grind Operation 4/21/2006



EDU Surface Figure Convergence during CCOS Processing



EDU Figure Grind Operation was extremely Successful:

- **Figure Grind Operation is Complete!**
 - Outstanding Figure Convergence through process
 - 41 Calendar Days (5.9 wks) Ahead of Baseline Schedule

EDU Currently in Smoothout Grind Operation



PMSA Vibro Acoustic TRL6 Testing at Ball



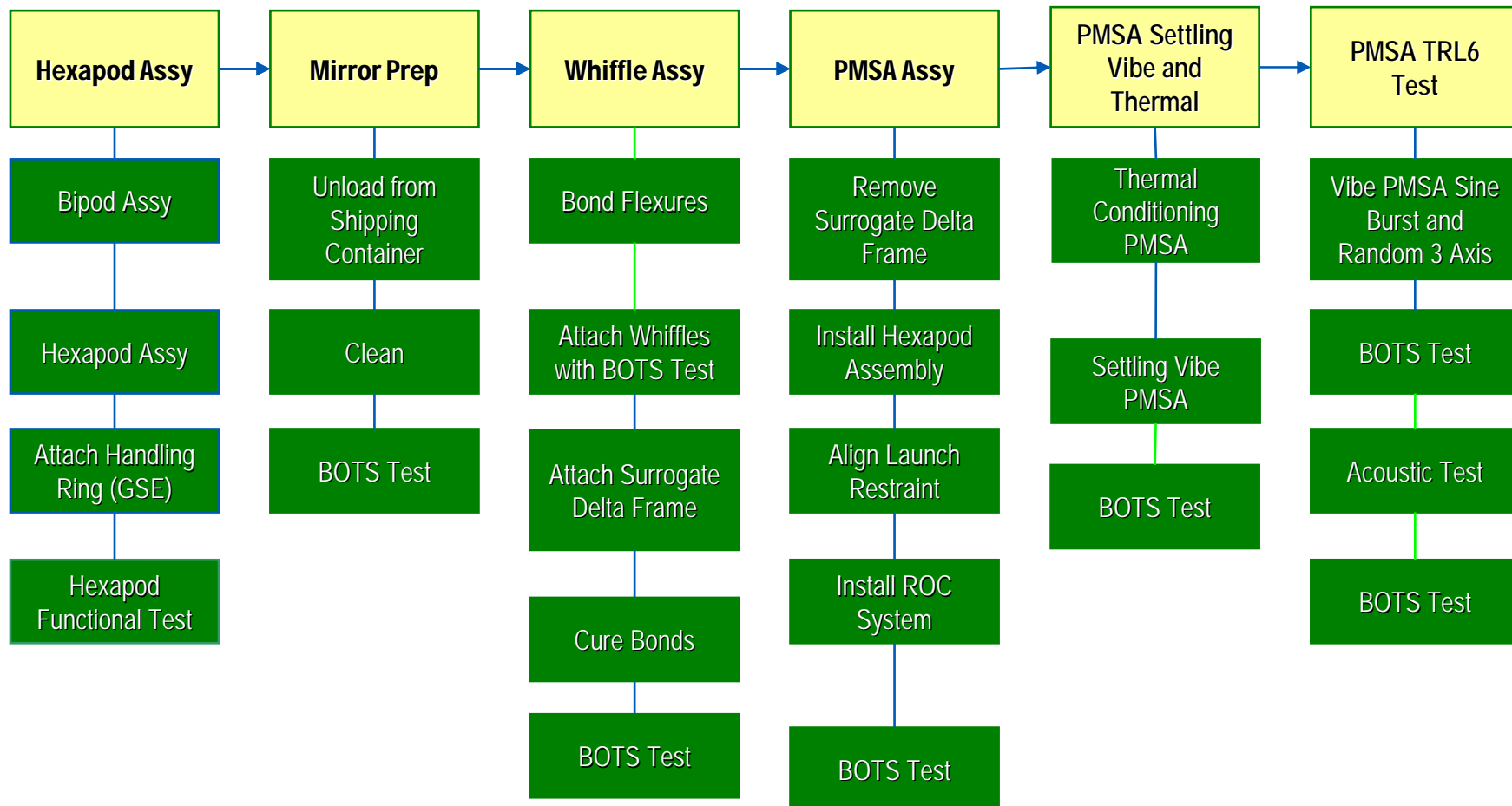
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- TRL6 Testing has required a full PMSA to be assembled for Vibration, Acoustic and Optical Testing
- B1 Segment was delivered to Ball in Configuration 1 and Ball fully integrated the segment and completed all required tests
- TRL6 Integration Flow:





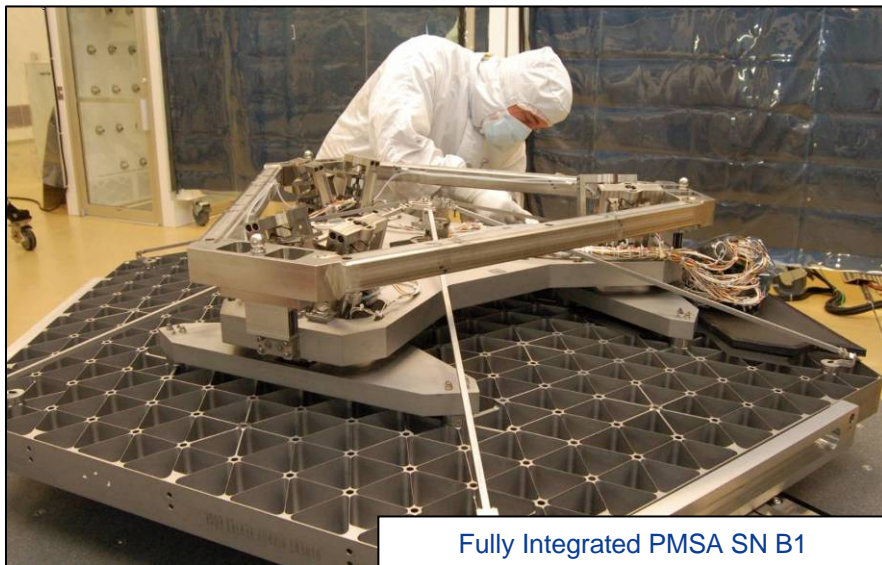
PMSA has Passed TRL6 Testing at BALL !!



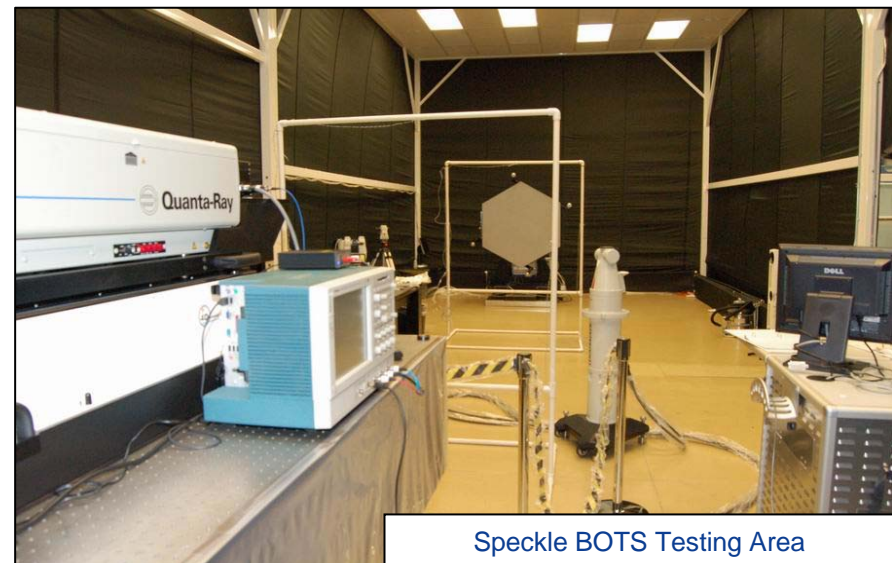
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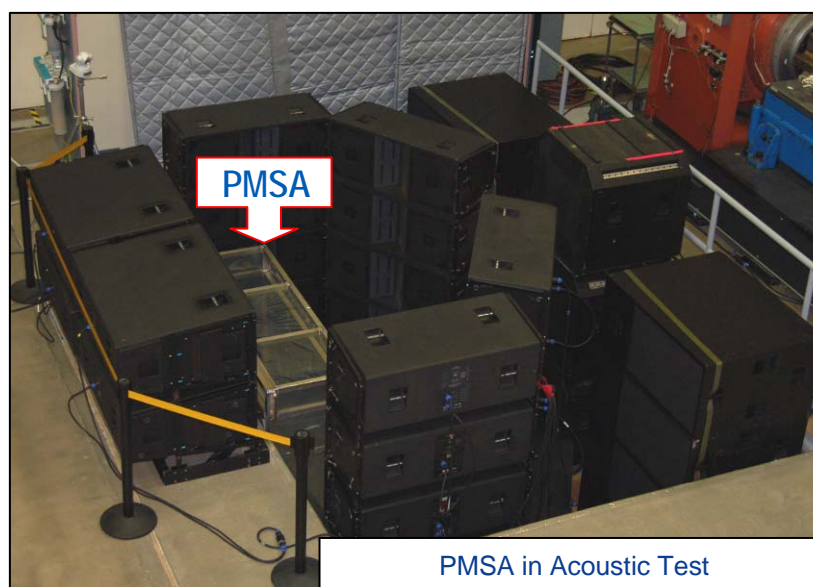
Fully Integrated PMSA SN B1



Speckle BOTS Testing Area



PMSA on Vibe Table



PMSA in Acoustic Test



PMSA in Speckle Test



JWST Mirror Manufacturing Summary



- **Ball Aerospace**
 - PMSA has Passed TRL6 Testing at Ball
 - Ball currently finishing up Speckle Interferometer testing prior to converting the clean room facility to a traditional Visible Interferometer test
- **Brush Wellman**
 - PM, SM, and TM Blank Manufacturing Completed
- **Axsys Technologies**
 - 8 PM Segments complete, 13 in work
 - SM processing has begun
 - TM blank has been received and processing has begun
- **Tinsley Laboratories**
 - Manufacturing Process & Metrology Equipment Development is Nearing Completion
 - CCOS operations on EDU have started
 - 6 Flight Primary Mirror Segments have been received
 - 3 Pathfinder Segments have been entered into Tinsley's manufacturing flow
- **XRCF**
 - Facility Upgrades In-Process